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PROGRESS REPORT  
PHASE I PRELIMINARY SITE CHARACTERIZATION INVESTIGATION  
UNION PACIFIC RAILROAD YARD  
LAS VEGAS, NEVADA  
FOR UNION PACIFIC RAILROAD

DAMES & MOORE JOB NO. 00173-028-042  
SANTA BARBARA, CALIFORNIA  
JULY 19, 1987

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**Dames & Moore**





**DAMES & MOORE**

A PROFESSIONAL LIMITED PARTNERSHIP

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July 19, 1987

Union Pacific Railroad  
1416 Dodge Street  
Omaha, Nebraska 68179

Attention: Mr. Robert Kuhn  
Director of Environmental Engineering

Gentlemen:

Transmitted with this letter is a copy of our progress report entitled, "Phase I Preliminary Site Characterization Investigation, Union Pacific Railroad Yard, Las Vegas, Nevada for Union Pacific Railroad Company." Our work plan for the Phase II investigation will be forthcoming in the next day or so. If you have any questions, please contact us in Santa Barbara at (805) 685-4415.

Respectfully submitted,

DAMES & MOORE

*Arthur C. Darrow/RNS*  
Arthur C. Darrow

General Manager-Western Region

*Richard N. Stout*  
Richard N. Stout  
Project Manager

ACD:RNS:ses  
cc: Mr. Gary Papek  
34.1G/14-1tr1

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LAS VEGAS, NEVADA  
FOR UNION PACIFIC RAILROAD

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1.0 INTRODUCTION

Presented in this report are the findings of our Phase I preliminary site characterization investigation for the Union Pacific railroad yard located in Las Vegas, Nevada (Figure 1). The investigation was performed in accordance with our work plan dated June 22, 1987.

The Phase I investigation was implemented to provide preliminary information regarding: (1) site history and current site usage; (2) The site hydrogeologic conditions; (3) the nature and distribution of soil and ground water contamination in several areas that were identified as likely to contain subsurface contamination; and, (4) potential remedial action alternatives. These data have been used in developing an efficient and cost effective Phase II program. Our scope of services for the Phase I investigation included:

- ° reviewing the site history;
- ° reviewing readily available hydrogeologic reports and data;
- ° drilling 25 exploratory borings;
- ° installing four ground-water monitoring wells;
- ° monitoring ground water levels;
- ° collecting and chemically testing soil and ground water samples;
- ° analyzing and interpreting data;
- ° screening potential remedial action alternatives; and,
- ° preparing a summary progress report.

At Union Pacific's request, our Phase I subsurface exploratory program was limited to the Union Pacific Railroad property and did not include the adjacent Upland properties (Figure 2). Specifically, exploratory drilling and sampling was conducted in the following areas:

- ° westbound and eastbound fueling areas;
- ° storage tank area;
- ° fuel car loading area;

- ° diesel shop area;
- ° battery shop area;
- ° evaporation pond area; and
- ° monitoring well MW-4 area.

The site history review included the Upland properties located west and east of the railroad yard and Union Pacific Railroad property. We will continue our review during Phase II to identify current and previous land uses in these areas.

## 2.0 SITE HISTORY REVIEW

### 2.1 INTRODUCTION

The site history review was divided into two elements relating to previous land ownership. One element included a review of the past and present operations of the railroad yard. The second element included a review of the past and present use of adjacent properties owned by Union Pacific Realty Company (UPRC) or its predecessors.

### 2.2 RAILROAD YARD AREA ASSESSMENT

Mr. Joe Kuebler of Dames & Moore visited the Las Vegas railroad yard to initiate the site history review on June 24 and 25, 1987. Mr. Kuebler reviewed all available file material, inspected the railroad yard and surrounding area, and spoke with several long-time Union Pacific employees. Certain file materials were copied and assessed for pertinent information. In addition, Mr. Kuebler visited Union Pacific headquarters in Omaha, Nebraska on July 1 and 2, 1987. The purpose of this visit was to review additional file material, microfile data, historical maps and drawings, and to interview available personnel familiar with the railroad yard operations. Additional maps and file materials were obtained and are currently being reviewed and evaluated.

### 2.3 UNION PACIFIC REALTY COMPANY AREA ASSESSMENT

Mr. Bob Ingersoll of Dames & Moore met with Mr. Louis L. Devay, Director of Development Services, Upland Industries Corporation on July 2, 1987 to discuss certain Las Vegas, Nevada properties owned by the UPRC. Mr. Devay was the project engineer when streets were constructed in the area during 1968 and

1969. Mr. Ingersoll also reviewed several reports and files pertaining to those properties on July 2, 1987.

The areas east of the railroad yard along Commerce and Main Streets are still being investigated. Certain information has been requested from Union Pacific personnel in Omaha regarding current and previous tenants and land owners. This information will be examined and results will be discussed as part of our Phase II work efforts.

The Phase I review encompassed the following UPRC properties, referenced to Upland Industries Corporation Map Nos. 3202-00-03 and 3202-00-04 and indicated on Figure 2:

- ° Parcel No. 1;
- ° Parcel No. 2;
- ° Parcel No. 3, including Parcel Nos. 46 and 48;
- ° Parcel No. 4;
- ° Parcel No. 5;
- ° Parcel No. 17;
- ° Parcel No. 38;
- ° Parcel No. 12; and,
- ° Property between Commerce Street/Main Street and Union Pacific Railroad property from Charleston Boulevard to Bonanza Road.

Three pieces of property in Parcel 3 had been sold and re-acquired by UPRC. Much of the property along Commerce Street and Main Street has been sold. In general, most of these parcels have not had prior use or development activities. The areas have been under ownership or lease by UPRC or its predecessors since the turn of the century.

As a result of the research performed to date, several areas were identified which warrant additional investigation. The areas which will be examined during Phase II, include:

- ° the rip track area;
- ° the garbage-filled depression area;
- ° the former garbage disposal area;
- ° the sludge and oil pits area; — unknown



- ° the diesel pits area;
- ° the substation area;
- ° the oil sump area;
- ° the railroad car disposal area;
- ° the day storage area;
- ° the tank truck loading area;
- ° the roundhouse area; and,
- ° the signal shop area.

### 3.0 SITE HYDROGEOLOGIC SETTING

#### 3.1 STRATIGRAPHY

Site stratigraphic conditions were investigated by drilling 29 exploratory borings (4 of which were completed as monitoring wells) to depths ranging from about 15 feet to 29 feet below ground surface (bgs) at the locations shown on Figures 3 through 7. Soils encountered during Phase I exploratory drilling are representative of interbedded Pleistocene and Holocene alluvial, playa, and lake deposits. The soils are predominantly fine grained and comprise alternating beds of silt, sand, and clay. Coarse sand and fine gravel were rarely encountered. Hard caliche zones were common, generally ranging between 1 and 6 feet in thickness. Bedding was characteristically discontinuous.

#### 3.2 GROUND WATER CONDITIONS

A sequence of four aquifer zones are recognized in the Las Vegas Valley. In descending order these aquifer zones are commonly referred to as the "near-surface reservoir" and the "principal aquifers" which are separated into shallow, middle, and deep zones (Maxey and Jameson, 1948). Ground water in the near-surface reservoir is not presently used; however, recent legislation allowing individuals to petition for use of this water has been enacted (personal communication, Las Vegas Valley Water District, 1987). The principal aquifers are currently a major water supply source for the Las Vegas area. *depth?*

*scoring problem* { Five ground-water monitoring wells previously installed at the site by Union Pacific and the four wells recently installed by Dames & Moore are inferred to be screened in the near-surface reservoir. Water level measurements obtained from the nine ground-water monitoring wells (completed to depths ranging from 23 to 27 feet bgs) indicate that depth to water on site

ranges from about 11 to 17 feet bgs, (elevation 2022 to 2013 feet above mean sea level (msl)). The thickness of the zone of saturation at the site is not known; however, the available literature indicates that it is on the order of 100 to 200 feet thick. In addition, the available literature reports the lack of a clear stratigraphic or hydraulic distinction between the near-surface reservoir and the shallow underlying principal aquifer. } good for scoring

Static water levels measured in borings and wells installed on site were frequently observed to be higher than the level at which saturated soil was first encountered during drilling. Based on this observation and the extensive occurrence of relatively impermeable clay and caliche lenses underlying the site, the near-surface aquifer is inferred to be semi-confined. Based on preliminary water level data from shallow on-site wells, the potentiometric surface has a gradient ranging from about 0.004 to 0.007 directed generally eastward.

location? Based on the available data reviewed during this investigation, there are no water supply wells within one mile of the site in the downgradient direction. However, two water supply wells that penetrate the principal aquifer zone are present on-site (Figure 7). Neither well is currently operating and a driller's log was available for one well (Las Vegas No.1). This well, located in the central portion of the site, was completed in 1920 and extends to a total depth of 780 feet bgs. Based on the driller's log, the stratigraphy in the vicinity of this well generally consists of interbedded "lime rock" (caliche), clay, and occasional sandstone to about 500 feet bgs. From 500 to 780 feet bgs, deposits generally consist of thick clay beds with thin interbeds of sandstone. A 10-foot thick layer of gravel occurs at a depth of 280 to 290 feet bgs. Water was observed to be flowing from this interval during drilling and the zone was subsequently screened. Water flow in the well bore increased when a 4-foot-thick gravel layer at 590 to 594 feet bgs was encountered. This zone was also screened. deep water aquifer

Current static water levels in the on-site water supply wells are not known. Based on 1973 data, the potentiometric surface of the deep aquifers underlying the site was approximately 1,955 feet msl, or at a depth of approximately 75 feet (Broadbent, 1980). This level suggests that a downward gradient potential may exist between the principal aquifers and the near-surface

reservoir in the site vicinity. Continued over-pumping of the principal aquifer since 1973 would be expected to create further reductions in potentiometric levels and, thus, a larger downward gradient potential. Regional water level data from 1973 indicate that the potentiometric surface of the principal aquifers had a gradient of approximately 0.015 directed to the east (Broadbent, 1980). More recent water level data were not available.

#### 4.0 SOIL AND GROUND WATER CONTAMINATION

##### 4.1 SOIL CONTAMINATION

###### 4.1.1 Petroleum Hydrocarbons

###### 4.1.1.1 Field Observations

Surface and/or subsurface soil hydrocarbon staining was observed in all areas investigated except the battery shop area. The depth interval of stained soils as observed in the exploratory boring is indicated in Table 1. Hydrocarbon odors were commonly associated with the soil staining. On rare occasion, hydrogen sulfide-like odors were associated with stained soil. Elevated concentrations of organic vapors (detected with an organic vapor analyzer (OVA)) were generally associated with the stained, odorous soils.

###### 4.1.1.2 Chemical Testing

Sixty soil samples were chemically tested for petroleum hydrocarbons by West Coast Analytical Services, Inc. (WCAS) of Santa Fe Springs, California using modified EPA Method 8015. Fifty-four of the samples were obtained from boreholes; six were surface soil samples. The results of the chemical testing are summarized in Table 2.

Petroleum hydrocarbons were detected in all areas investigated during Phase I. Moreover, approximately 85 percent of the borings drilled yielded detectable concentrations of petroleum hydrocarbons. In general, the results indicate that additional data are needed to complete an evaluation of the distribution of petroleum hydrocarbon contamination at the site.

###### 4.1.2 Other Contaminants

Seven soil samples (B-2-1A, B-3-2A, B-13-4A, B-16-4A, B-25-3A, SS-1-1A, and SS-5-5A) were analyzed by WCAS for priority pollutants using the following methods:

*Is there a problem*

*No allowable concentrations yet*

- ° EPA Method 8240 - Volatile Organic Compounds (VOCs);
- ° EPA Method 8270 - Semi-Volatile Organic Compounds (SVOCs);
- ° EPA Method 8080 - Organochlorine Pesticides and PCBs (OPs & PCBs); and,
- ° Various EPA Methods - Priority Pollutant Metals.

In addition, samples B-17-4A, SS-4-4A, and SS-6-6A were analyzed for VOCs, and SS-2-2A and SS-3-3A were analyzed for priority pollutant metals according to the above-referenced procedures.

The results of these analyses are summarized in Table 3. VOCs were detected in soil in the vicinity of the diesel shop only (SS-4-4A, SS-5-5A, and SS-6-6A). SVOCs detected in sample B-13-4A are apparently related to the bunker fuel detected in that borehole. Indistinguishable SVOC compounds were also detected in B-25-3A and SS-5-5A. Single OP & PCB compounds were detected in SS-1-1A (75 ppb chlorodane) and SS-5-5A (220 ppb PCB-1260). Priority pollutant metals were detected in all of the surface soil samples. The only metals detected were lead, zinc, copper, and antimony. The highest concentrations detected were 2,800 ppm zinc in the battery shop area and 1,500 ppm lead in the diesel shop area.

PCBs

are these above allowable?

#### 4.2 GROUND WATER CONTAMINATION

##### 4.2.1 Petroleum Hydrocarbons

##### 4.2.1.1 Field Observations

Free phase petroleum hydrocarbon was observed on the ground water surface in 18 of the 25 borings drilled during Phase I. In addition, one of the four wells that were installed also contained petroleum hydrocarbons. In general, the thickness of hydrocarbon on ground water in the boreholes was measured within 12 to 24 hours of completion. Table 1 shows the approximate thickness of petroleum hydrocarbons measured on ground water in the open boreholes. Based on visual inspection, the hydrocarbon observed on ground water in borings drilled at the westbound fueling, eastbound fueling, and diesel shop areas appear to be diesel fuel. In the storage tank/fuel loading area, the petroleum hydrocarbon appears to be diesel fuel in borings B-9 and B-10 and bunker fuel in B-12, B-13 and B-14. The extent of the accumulations of petroleum hydrocarbons on ground water is not known.

what is

##### 4.2.1.2 Chemical Testing

Eight water samples were collected from the site monitoring wells and

chemically tested by WCAS for petroleum hydrocarbons by modified EPA method 8015. Monitoring well MW-5 contains several feet of bunker fuel; therefore a ground water sample was not collected from this well. Petroleum hydrocarbons were not detected in samples from wells MW-1, MW-2, MW-3, DM-1, DM-2, DM-3, and DM-4 (Table 2). Petroleum hydrocarbon (diesel) was detected in MW-4 at a concentration of 6,100 ppm. The water sample obtained from MW-4 contained a small amount of immiscible hydrocarbon which obviously would increase the concentration detected in the sample. <sup>2</sup>

#### 4.2.2 Other Contaminants

An upgradient water sample (DM-2-2A) and a downgradient water sample (MW-3-3A) were analyzed by WCAS for priority pollutants in accordance with:

- EPA Method 624 - Volatile Organic Compounds (VOCs);
- EPA Method 625 - Semi-Volatile Organic Compounds (SVOCs);
- EPA Method 608 - Organochlorine Pesticides and PCBs (OPs & PCBs); and,
- Various EPA Methods - Priority Pollutant Metals.

These results are also summarized on Table 3. Low concentrations of VOC species were detected in MW-2-2A (3 ppb chloroform) and MW-3-3A (3 ppb toluene). DM-2-2A yielded one SVOC compound (9 ppb anthracene) while MW-3-3A contained four SVOC species including 2-methyl naphthalene (5 ppb), acenaphthene (8 ppb), fluorene (4 ppb), and C<sub>10</sub> to C<sub>25</sub> hydrocarbons (4,000 ppb). No OPs & PCBs or priority pollutant metals were detected in the two water samples.

### 5.0 REMEDIAL ALTERNATIVES REVIEW

A preliminary remedial alternatives screening study for the Union Pacific Las Vegas site was conducted by Dames & Moore. The results of the preliminary screening are presented in Table 4. As part of the study, a range of remedial action options was identified. These options were then screened on the basis of technical merit and practicality and assigned a relative rating. The alternatives rated L (low), M (medium), or H (high) represent those which Dames & Moore considers potentially applicable to the site. Alternatives rated I (Inappropriate given present data base) or U (Unable to rate given present data base) will be further evaluated during the course of subsequent

investigations. In addition, the overall review of the remedial alternatives will be continued during Phase II. As more chemical and hydrogeologic data are made available the list of alternatives will be refined.

#### 6.0 CONCLUSIONS

Based on the results of our Phase I investigation (including preliminary chemical data), we conclude that additional data are required to further evaluate the distribution and volume of petroleum hydrocarbons, VOCs, SVOCs, OPs & PCBs and priority pollutant metals have been detected at the site. Furthermore, free phase petroleum hydrocarbons and dissolved VOCs and SVOCs have been detected on and in ground water at several locations on the site. Further investigation is needed to evaluate the nature and extent of the free phase and dissolved contaminants. In addition, specific information regarding the ground water flow regime are needed. This information includes: (1) vertical gradients; and (2) ground water level data to further assess the ground water surface configuration. Finally, several additional sites possibly containing hazardous materials and therefore warranting further evaluation have been identified as a result of our site history review.

TABLE 1

## FIELD OBSERVATIONS

Boring No.	Approximate Depth Interval of Visibly Stained Soil (feet bgs)	Approximate Thickness of Petroleum Hydrocarbon On Ground Water (feet)
B-1	None	2.3
B-2	0-2	4
B-3	None	3.3
B-4	None	2.5
B-5	10-12	1.5
B-6	None	None
B-9	None	<0.1
B-10	None	<0.1
B-11	None	None
B-12	0-9	1
B-13	0-15	<0.1
B-14	None	<0.1
B-15	0-15	None
B-16	None	None
B-17	0-3	None
B-18	5-6	--
B-19	0-4	None
B-20	0-1	<0.1
B-21	0-3	<0.1
B-22	None	0.3
B-23	None	<0.1
B-24	None	None
B-25	None	<0.1
B-26	None	0.3
B-27	None	Film

Westbound  
Fueling area

NOTE: <0.1 indicates less than 0.1 foot but more than a film of petroleum hydrocarbon was detected on ground water in the boring.

-- Indicates measurement was not obtained

TABLE 2

SOIL AND GROUND WATER CHEMICAL  
TEST RESULTS  
Petroleum Hydrocarbons

Are there  
any problems

Boring/ Well No.	Sample No.	Depth (Feet)	Total Petroleum Hydrocarbon Concentration (ppm)
B-1	2A	6	<2
	4A	15	7,600
B-2	1A	1	<2
	3B	11	<2
	4A	16	2,900
B-3	2A	6	<2
	4A	15	610
B-4	2A	6	<2
	4A	16	5,700
B-5	1A	1	<2
	3A	10	<2
	4A	15	4,300
B-6	3A	10	340
	4A	16	470
B-9	2A	7.5	<2
	5A	21	<2
B-10	2A	7	6,600
	3A	10	<2
B-11	2A	6	<2
	4A	16	<2
B-12	2A	6	3,700
	4B	16	270
B-13	2A	5	3,200
	4A	15	4,900
B-14	2A	6	<2
	3A	13.5	1,400
B-15	2A	6	1,200
	3A	12.5	76

Subtracted  
with free  
product



TABLE 2 Continued

Boring/ Well No.	Sample No.	Depth (Feet)	Total Petroleum Hydrocarbon Concentration (ppm)
B-16	2A	6	<2
	4A	20	170
B-17	2A	6	<2
	4A	18	<2
B-18	2A	6	1,620
	3A	10.5	<2
B-19	2B	6	14,000
	3A	11	2,600
B-20	2A	6	<2
	3A	11	1,900
B-21	2A	6	<2
	3A	11	6,300
B-22	2A	6	<2
	4A	15	1,900
B-23	2A	6	<2
	3A	11	<2
B-24	1B	3	TR
	3B	11	1,900
	4A	16	750
B-25	2A	6	<2
	3A	10.5	<2
	4A	15	410
B-26	2A	6	7,100
	4A	15	2,800
B-27	2A	6	32,000
	4A	16	40

TABLE 2 Concluded

Boring/ Well No.	Sample No.	Depth (Feet)	Total Petroleum Hydrocarbon Concentration (ppm)
SS-1	1A	1	<2
SS-2	2A	1	<2
SS-3	3A	1	12
SS-4	4A	1	5,280
SS-5	5A	1	110
SS-6	6A	1	4,100
DM-1	1A	gw	<2
DM-2	2A	gw	<2
DM-3	3A	gw	<2
DM-4	4A	gw	<2
MW-1	1A	gw	<2
MW-2	3A	gw	<2
MW-3	3A	gw	<2
MW-4	4A	gw	6,100
MW-5	5A	gw	NS

---

B - Exploratory Boring

SS - Surface Sample

DM, MW - Monitoring Well Sample

NS - Not Sampled

TR - Trace

gw - ground water

TABLE 3

SOIL AND GROUND WATER CHEMICAL TEST RESULTS  
OTHER CONTAMINANTS

Boring/Well No.	Sample Number	Volatile Organics Compounds (ppb)		Semi-Volatile Organic Compounds (ppb)		Organochlorine Pesticides and PCBs (ppb)	Metals (ppm)
B-2	1A		ND		ND	ND	ND
B-3	2A		ND		ND	ND	ND
B-13	4A		ND	Naphthalene 3,400 2-Methyl Naphthalene 13,000 Acenaphthene 710 Fluorene 1,400 Phenanthrene 4,600 Pyrene 1,100 Chrysene 1,000 C <sub>8</sub> -C <sub>35</sub> Hydrocarbons* 2,000,000		ND	ND
B-16	4A		ND		ND	ND	ND
B-17	4A		ND				ND
B-25	3A		ND	C <sub>10</sub> -C <sub>30</sub> Hydrocarbons* 300,000		ND	ND
SS-1	1A		ND		ND	Chlordane 75	Pb 820 Sb 13
SS-2	2A						Pb 42
SS-3	3A						Pb 437 Zn 140
SS-4	4A	Acetone 120 Toluene 88 1,4-Dichlorobenzene 22 Unknown 40			NA	NA	Pb 58
SS-5	5A	Tetrachloroethene 63 Toluene 20		C <sub>12</sub> -C <sub>35</sub> Hydrocarbons* 700,000		PCB-1260 220	Pb 1,500 Zn 240  Cu 370 Sb 8
SS-6	6A	Acetone 190 Carbon Disulfide 62 1,1-Dichloroethane 110 Trichloroethene 71 Tetrachloroethene 160 Toluene 50 Metachlorotoluene 63 1,4-Dichlorobenzene 9 1,2-Dichlorobenzene 190 cis-1,2 Tetrachloroethene* 200 C <sub>8</sub> -C <sub>11</sub> Hydrocarbons* 4,000			NA	NA	Pb 28
DM-2	2A (water)	Chloroform 3		Atrazine 9		ND	ND
MW-3	3A (water)	Toluene 3		2-Methyl Naphthalene 5 Acenaphthene 8 Fluorene 4 C <sub>10</sub> -C <sub>25</sub> Hydrocarbons* 4,000		ND	ND

ppb = parts per billion

ppm = parts per million

ND = not detected

NA = not analyzed

\* = tentatively identified compounds

34.10/16-T1

10 ppm — cleanup on pcb  
however site specific

TABLE 4

REMEDIAL ALTERNATIVE TECHNOLOGIES/RATING  
(Page 1 of 5)

<u>CATEGORIES AND TECHNOLOGIES</u>	<u>RATING</u>	<u>COMMENTS</u>
I. Ground Water Containment and Removal		
A. Infiltration Control		
- Capping	M	May not be necessary due to low precipitation/high evaporation in the area
B. Subsurface Barriers		
- Slurry Wall	L	Trenching through caliche to install wall may be impossible
- Grout Curtain	I	Installation may be impossible; curtains generally too permeable
- Sheet Piling	L	Installation may be impossible due to caliche
C. Injection Wells	L	Aquifer hydraulic conductivity may be too low to sustain injection; inhibits offsite migration only; potential permitting problems
D. Ground Water Pumping		
- Extraction Wells	M/H	Aquifer hydraulic conductivity may be too low to sustain pumping
- Well Points/ Suction Wells	M/H	Aquifer hydraulic conductivity may be too low to sustain pumping
- Vacuum Well Enhanced	L	Applicable to soil and ground water VOC contamination
D. Subsurface Drains	L	Required trenching may be impossible due to caliche

---

H - High

M - Medium

L - Low

I - Inappropriate at Present

U - Unknown - insufficient data are available at present to rate

34.1G/14-14.1

→ Can't they use construction techniques just for caliche?

TABLE 4

REMEDIAL ALTERNATIVE TECHNOLOGIES/RATING  
(Page 2 of 5)

CATEGORIES AND TECHNOLOGIES	RATING	COMMENTS
II. Water Treatment		
A. Physical/Chemical		
- Air Stripping	L	Diesel and bunker fuel components generally low volatility and not conducive to air stripping
- Carbon Adsorption	H	Can be effective with heavy organic components that characterize diesel and bunker fuel
- Gravity Separation	H	Applicable pretreatment for immiscible hydrocarbon and water phases
- Filtration/ Sedimentation	H	Possibly an important process to remove emulsified oil and suspended solids upstream of carbon treatment
- Precipitation	U	Possibly applicable to removal of metals
- Ion Exchange/ Sorbptive Resins	U	Possibly applicable to removal of metals
- Reverse Osmosis	U	Possibly applicable to removal of metals
- Oxidation/Reduction	U	Possibly applicable to removal of metals
- Wet Air Oxidation	I	Pretreatment only; potential for generating more toxic byproducts
B. Biological		
- Activated Sludge	M	Applicable to dissolved hydrocarbons; slow rate of treatment; pretreatment required
- Rotating Biological Contactors	M	Applicable to dissolved hydrocarbons; slow rate of treatment; pretreatment required
- Trickling Filters	M	Applicable to dissolved hydrocarbons; slow rate of treatment; pretreatment required

H - High

M - Medium

L - Low

I - Inappropriate at Present

U - Unknown-insufficeint data are available at present to rate

34.1G/14-T4.2

TABLE 4

REMEDIAL ALTERNATIVE TECHNOLOGIES/RATING  
(Page 3 of 5)

<u>CATEGORIES AND TECHNOLOGIES</u>	<u>RATING</u>	<u>COMMENTS</u>
- Activated Biological Filtration Towers	M	Applicable to dissolved hydrocarbons; slow rate of treatment; pretreatment required
- Ponds	M	Applicable to dissolved hydrocarbons; slow rate of treatment; pretreatment required
III. Effluent Management		
A. Aquifer Recharge	M	Dependent on hydraulic conductivity of aquifer; potential permitting problems
B. Surface Water Discharge	L	Potential permitting problems
C. Sewer Discharge	L	Potential permitting problems
D. Irrigation	U	Dependent on local needs
E. Industrial Use	U	Dependent on local needs
IV. In Situ Treatment		
A. Soil Flushing/Recovery	L	Early stage of technological development; fine- grained soils may not allow for effective flushing

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H - High

M - Medium

L - Low

I - Inappropriate at Present

U - Unknown-insufficeint data are available at present to rate

34.1G/14-T4.3

TABLE 4

REMEDIAL ALTERNATIVE TECHNOLOGIES/RATING  
(Page 4 of 5)

CATEGORIES AND TECHNOLOGIES	RATING	COMMENTS
B. Soil Vapor Extraction	M	Fine-grained soils may not be conducive to vapor extraction; less effective with heavier hydrocarbons such as diesel fuel; not applicable to bunker fuel
C. Immobilization		
- Precipitation	I	Not applicable to organic compounds; very limited development
- Polymerization	I	Very limited applicability and early stage of development
- Solidification	I	Conceptual technology
D. Detoxification		
- Enzymatic Degradation	I	Conceptual technology
- Permeable Treatment Beds	L/I	Temporary measure; may be effective in reducing offsite migration only; if installed, would require subsequent excavation and removal
E. Bioreclamation		
- Enhancement (Anaerobic)	M	Applicable to dissolved hydrocarbons; slow rate of treatment
- Custom Organisms	L	Applicable to dissolved hydrocarbons that are difficult to degrade; requires very controlled soil conditions
F. Physical		
- Heating	I	Not applicable to industrial sites
- Ground Freezing	I	Temporary treatment only
- Vitrification	I	Depth limitations; volatile gas evolution

H - High

M - Medium

L - Low

I - Inappropriate at Present

U - Unknown-insufficeint data are available at present to rate

34.1G/14-T4.4

TABLE 4

REMEDIAL ALTERNATIVE TECHNOLOGIES/RATING  
(Page 5 of 5)

<u>CATEGORIES AND TECHNOLOGIES</u>	<u>RATING</u>	<u>COMMENTS</u>
V. Soil Excavation		
A. Treatment		
- Biotreatment	M/H	Applicable to petroleum hydrocarbon contamination only
- Passive Aeration	M	Potential air emissions problems; may not attain non-hazardous levels in soil; less effective with heavier hydrocarbons such as diesel fuel; not applicable to bunker fuel
- Drum Washing	L	Two-stage treatment process
- Thermal stripping	M	Applicable to diesel fuel contamination only
- Air Stripping	M	May not attain non-hazardous levels in soil; less effective with diesel not applicable to bunker fuel
- Incineration	L	Limited availability; permitting problems
B. Disposal		
- Onsite	I	RCRA permit restrictions
- Offsite	H	
VI. No Action	L	Subject to regulatory agency approval; potentially applicable to certain onsite areas

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H - High

M - Medium

L - Low

I - Inappropriate at Present

U - Unknown-insufficeint data are available at present to rate

34.1G/14-T4.5



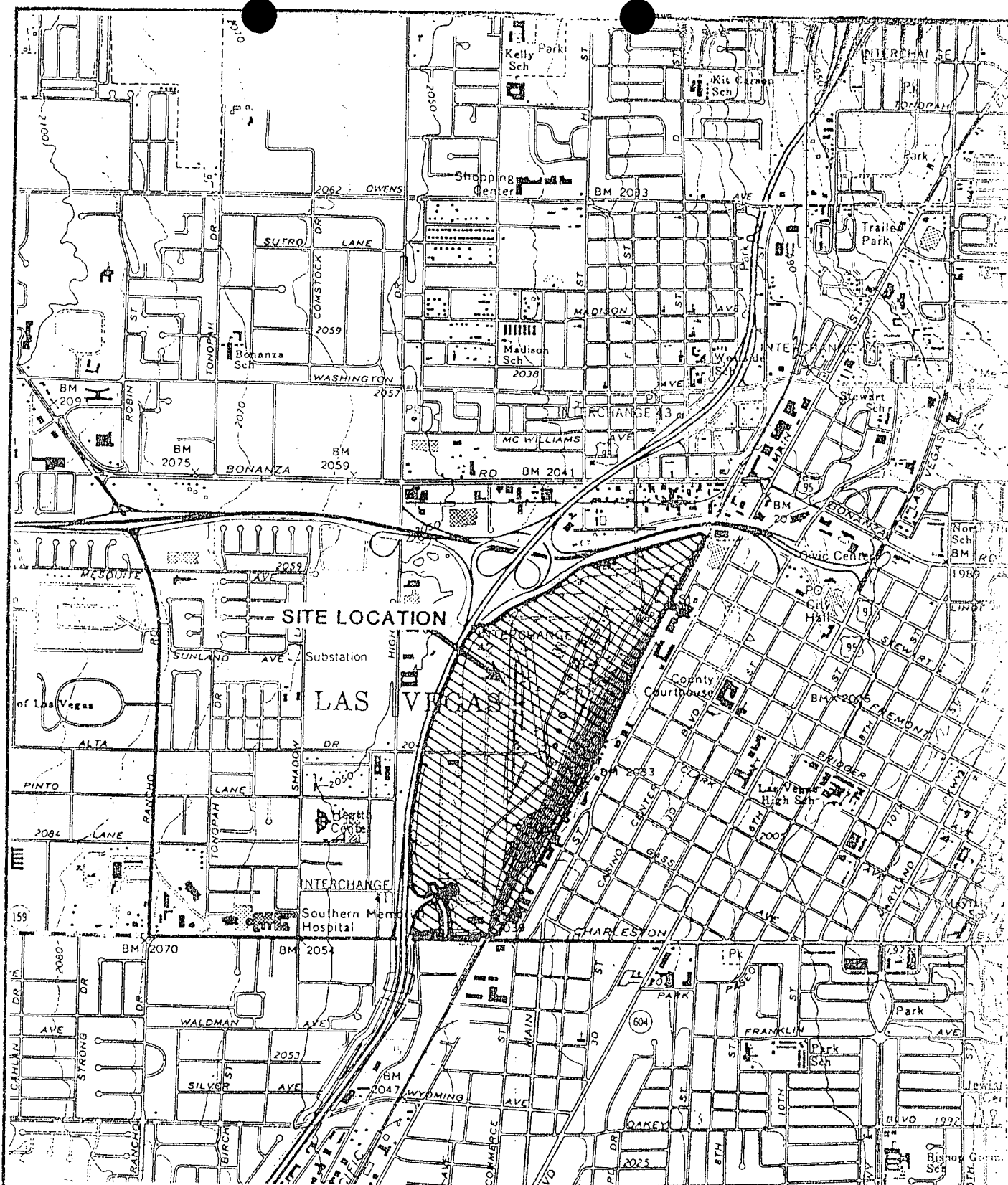


FIGURE 1

## SITE LOCATION MAP

Dames & Moore